Clean Sky 2
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Skyline

Innovation takes off

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Join the European aviation partnership!

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CLEAN SKY AT PARIS INTERNATIONAL AIRSHOW 2017

INTERNATIONAL PARIS AIR SHOW

VISIT CLEAN SKY AT PARIS INTERNATIONAL AIRSHOW 2017

- **EU-Clean Sky joint stand: Hall 2B – G125**
- **Clean Sky in the Air Lab Zone: Concorde Hall – C03**

Clean Sky will be present at the Paris International Airshow 2017, bringing together the aeronautical community and members of the public under one roof. Clean Sky will showcase a number of cutting-edge green technologies to highlight the remarkable progress the programme has made since its inception.

This year, we will be hosting a joint stand with the European Commission that will feature several pieces of hardware across all our activities as well as videos. Clean Sky will also be present in the brand-new Air Lab Zone which is entirely dedicated to innovation in the aerospace sector – aptly set against the backdrop of two Concorde aircraft on permanent display.

The Clean Sky talk 'Be part of the EU investment in aviation' will take place in the Air Lab Zone from 4:00-5:00pm on Monday 19 June with a range of expert speakers, and there will also be numerous talks held throughout the week. It promises to round-off an engaging programme at Le Bourget, so come and join us!

Stay updated on www.cleansky.eu/event/clean-sky-at-paris-international-airshow-2017

EDITORIAL

Clara de la Torre
Director for Transport, Directorate-General for Research and Innovation, European Commission

This year, we are celebrating the 60th anniversary of the European project. At this occasion, the European Commission issued a White Paper on the Future of Europe, launching a debate on possible directions for the coming years. We should not forget that Europe has always been at its best when it is united, bold and confident that we can shape our future in partnership.

We are also celebrating the 10th anniversary of the launch of the European aviation research partnerships, Clean Sky and SESAR. Funded through the latest EU Research and Innovation Framework Programmes, they are the main R&I investment to implement the new European aviation strategy and the Strategic Research and Innovation Agenda from ACARE, the Advisory Council for Aviation Research and Innovation in Europe.

While SESAR focuses on developing the new European air traffic management system, Clean Sky is a European partnership for new energy-efficient aircraft technologies. It is about working together at the European level to develop green technologies that both the public and private sectors are convinced will improve our environment and maintain our competitiveness. Collaborating at European level has helped the European aeronautics supply chain stay in good shape, by spreading to new regions and countries and playing a key role in building a Europe with more growth and jobs. I hope you will enjoy a number of testimonials in this issue from different Clean Sky actors, such as Member States, industry, academia and research centres.

The results of the collaborative research in Clean Sky are well-placed in the wider context of the EU's vision on sustainable transport in Europe. The aeronautical industry is a continuously growing sector of excellence in Europe and an important source of jobs and exports. However, in order to tackle the impact of aviation on the planet and to cement the industry's future growth, we cannot rest on our laurels. Clean Sky was established in 2007 precisely to meet such challenges – environment, competiveness and mobility – which are central to its existence, as Europe strives to develop a more innovative and greener aircraft today that will better equip the European aviation industry of tomorrow. With the adoption of the historic Paris Agreement on climate change and the release of the European Commission's new aviation strategy, the message is clear: aviation and the whole transport sector need to accelerate the development and introduction of environmentally friendly products and services. This underlines the fact that the objectives and goals set for Clean Sky have been significant steps in the right direction and are more important today than ever.

As we scan the near horizon, the European Commission–Clean Sky joint stand at the International Paris Le Bourget Air Show, in June 2017, will highlight the large investment that the European Union is making in sustainable aviation through several related programmes. These include not only Clean Sky, but also SESAR, Horizon 2020 projects managed by the Innovation and Networks Executive Agency (INEA), Galileo, Marie Skłodowska-Curie actions and the SME Instrument. Many companies, research centres and universities from across Europe are already part of this substantial effort to improve the energy efficiency and environmental performance of aviation and to keep Europe at the forefront of innovation. For those who are not yet part of it, you can learn more in this issue of Skyline about how to apply to the programmes. We really hope to see you joining our collaborative effort at the European level!

Our objective at Le Bourget is to reach out to even more potential participants and reward talent from every corner of the European Union. Working together, we will be able to maintain European leadership and solve the societal challenges for the benefit of all. The European Commission and the Clean Sky 2 Joint Undertaking are ready to join you in this journey for a stronger Europe. Come and visit us at Le Bourget 2017 or read more online at **http://cleansky.eu/event/clean-sky-at-paris-international-airshow-2017**

A VISION FOR FUTURE AVIATION

Tiit Jürimäe
Clean Sky 2 JU Interim Executive Director
Sebastiano Fumero
European Commission, Head of Aviation Research Unit

Every year, the European Union is funding thousands of researchers and innovators across Europe to work together, to make our aeroplanes safer, greener and more competitive.

The EU considers this very important, as it believes that people, education, research and innovation are the foundations of our society. These are some of the reasons that enabled Europe to become a world leader in aircraft technology. EU funding helps to ensure that it remains at the cutting edge. Aviation is not only one of the leading high-tech sectors in Europe, but it also supports around 8.7 million jobs.

Current European funding comes from the Horizon 2020 research framework programme, mainly through its smart, green and integrated transport challenge. This funding is largely focussed on three priority areas.

The first challenge is to solve the environmental issues that aviation is facing. The sector has already set itself ambitious environmental targets in Europe's vision for future aviation, Flightpath 2050. This aims to cut CO_2 emissions by 75%, and to reduce NO_x emissions by 90% in comparison to the year 2000. In addition to these ambitious targets, the international Paris Agreement on climate change goal is to further limit global warming and it is likely that the sector will have to intensify its efforts to become even greener.

The second challenge relates to air transport. With the massive increase in traffic, airspace and airports are becoming gradually more congested and may not be able to accommodate all flights in the near future. Reducing aviation noise is also very important to allow air transport to continue growing.

The third challenge, is regarding Europe's competitiveness. Aviation is creating global opportunities for our industries and with predicted annual growth rates of 4-5% expected in the coming years, the size of this potential market is enormous. It is therefore imperative to ensure that Europe benefits from this growth, while facing increased competition, both from throughout the world and from emerging industrial sectors.

Back in 2007, Europe realised that public and private stakeholders have to join forces in replying to these challenges. Thus it created the Clean Sky and SESAR public-private partnerships – co-financed by the framework programmes for research and technological development – to bring all the main stakeholders together in common programmes to develop greener aviation technologies and to address the capacity and congestion problems.

By working jointly in public-private partnerships, industry has the opportunity to better address this competitiveness challenge and to ensure that Europe stays at the forefront, both in traditional and emerging markets.

Since 2014, deployment efforts have also been supported by European infrastructure investments from the Connecting Europe Facility (CEF). SESAR's activities have recently also expanded to tackle the new challenge of integrating drones into the airspace.

The first Clean Sky programme has now closed. Around 600 organisations worked together over 10 years on various technology demonstrators. The cost of the € 1.6 billion programme was shared equally by the public and private sectors. Not only research results are already apparent; but also some demonstrators have been flight tested and these environmental improvements can now start their journey onto the market. Since 2014, the second Clean Sky programme – Clean Sky 2 – took over with the same objectives. You will find a brief overview of this effort at our joint stand at the Le Bourget 2017 air show or online: **www.cleansky.eu**

Whilst most European investments are via these partnerships, there are also additional opportunities. Through annual calls in the Horizon 2020 transport challenge, between 2014 and 2020 about € 300 million is being invested in various aviation topics. These are mainly bottom-up, open calls, thus allowing a wide range of ideas to be put forward for developing new technologies and ensuring that new ideas continue to flow into the sector.

In addition, many other parts of the Horizon 2020 programme are also of direct interest and benefit to the aviation sector – direct funding for SMEs; equity and loan facilities; and calls on manufacturing, new materials, robotics, digital technologies, security and cyber-security, alternative fuels etc. The list is almost endless and again we highly recommend that you visit our joint stand at the Le Bourget 2017 air show for daily presentations of the various opportunities or explore the Horizon 2020 participants' portal website.

The European Commission does not manage those programmes alone. In addition to the Clean Sky 2 and SESAR Joint Undertakings, for the transport topics it is supported by the Innovation and Networks Executive Agency (INEA), which manages the information days, calls and projects on behalf of the Commission. Other parts of the Horizon 2020 programme are managed by the European Research Council (ERC), by the Research Executive Agency (REA) and by other relevant Agencies.

The next calls of the Horizon 2020 transport programme will be launched in autumn 2017. So now is a good time to start reflecting on how your organisation could contribute to this joint effort of addressing the societal challenges that European aviation is facing. We invite everybody to apply and to put forward their ideas. The European Commission, the Joint Undertakings and the Agencies are here to help you and together we can continue to maintain aviation as a true European success story.

Links:

- International Paris Air Show: www.siae.fr/en/
- Horizon 2020 Participants Portal https://ec.europa.eu/research/participants/portal/desktop/en
- Horizon 2020 for Aviation: https://ec.europa.eu/programmes/horizon2020/en/area/transport
- European Commission R&I Aviation Transport: http://ec.europa.eu/research/transport/index.cfm?pg=transport&lib=air
- Clean Sky 2 Joint Undertaking: www.cleansky.eu
- @EUScienceInnov
- @EU_H2020
- #EUTransportResearch
- #InvestEU
- @cleansky_ju

MORE REVOLUTIONARY, MORE DISRUPTIVE

Rolf Henke
Chair of ACARE. Interview by Paul Sillers

What is your background and what made you enter the aeronautics sector?

I have always been seriously fascinated with aviation. As a young person I had been to the Hanover Air Show, and its successor the Berlin Air Show several times – I must have caught the 'aviation fire' there. So I studied aeronautics at the University of Berlin and worked with Airbus for 20 years. Afterwards, in 2006, I became Professor of Aeronautics and Astronautics at the Technical University of Rhineland Westphalia in Aachen and Head of the Institute of Aerospace Technology. Currently, I am Member of the Executive Board for aeronautics research at DLR German Aerospace Center, president of the German aerospace society DGLR, and chair of the Advisory Council for Aviation Research and Innovation in Europe.

What led you to Clean Sky Joint Undertaking and what first drew your attention to the programme?

I have been involved with Clean Sky from the start. At that time I was still with Airbus. It goes back to Vision 2020, which was a shared vision of government, academia and industry. As the strategic research agenda developed, it became clear that we needed a larger scale demonstration which was only feasible through a European partnership. The consecutive Level 1, 2 and 3 projects were, you could say, the birth of Clean Sky. It was a two way initiative from both, industry and the Commission. Then, after my time at Airbus, Clean Sky activities accompanied me throughout my time at the University in Aachen, and they still do now while I am at DLR. As you probably know, DLR is leading Clean Sky 2's Technology Evaluator (TE). So over time I have experienced Clean Sky in very different roles and at different stages. I was involved in its preparation and today I am a member of the Governing Board as well as an Executive of DLR that is head of the TE.

> "Large Demonstration programmes promote engagement, develop experience and facilitate 'hands-on' work for our employees."

Based on your experience, what should be encouraged about the Clean Sky programme and what is the most exciting thing about Clean Sky?

I think for the future we should have a broader view – start at TRL1 or maybe TRL2 and cover the whole range until TRL6; but we should have the final product in mind from the beginning.

I also think we should be more revolutionary, more disruptive. We could be more daring in terms of aircraft configurations and new propulsion systems. We should then think about how to produce it, to a certain extent perhaps with Additive Layer Manufacturing, and what the factory of the future will need to look like. Digitalization promises to save time and money from aircraft design all the way to its certification in the future. But of course it is easy to spend a lot of money purely on potentially disruptive ideas. What we need to do is find a balance between being careful with the budget on one side and being daring with ideas on the other.

Being asked to name the most exciting thing about Clean Sky, I would say it is the large demonstrators. We have ground demonstrators and they are fascinating. But personally I love the flight tests, and I am convinced that we need flight tests. Apart from serving industry's needs, the large demonstration programmes help promote engagement, develop experience and facilitate "hands-on" work for our future employees and students – this is very important for the future of European aeronautics.

In Clean Sky 2 I think we have a pretty good balance now between the large companies, SMEs and academia. Clean Sky 2 is already on track and we will hopefully see a continuation of Clean Sky and aviation research in the next framework programme – we now have to think about FP9 and what the setup will be.

WE DELIVERED. THAT GIVES ME CONFIDENCE IN CLEAN SKY 2

Valérie Guénon
VP, Programs & Leadership at SAFRAN University. Interview by Paul Sillers.

What is your background and what made you enter the aeronautics sector?

I graduated in mechanical engineering from the Université de Technologie de Compiègne, followed by a Masters at the University of Delaware. Whilst in the States I did research for a NASA contract and found the level of innovation in the aerospace sector really motivating. Returning to France, being a specialist in composite materials opened doors to job offers in automotive and sports equipment sectors, but there was an opportunity to work with SNECMA – a forerunner of Safran. The aircraft engine manufacturer sought to put composites in their products, and that was a real attraction and a great fit with my background.

What led you to Clean Sky Joint Undertaking and what first drew your attention to the programme?

I'm proud to say I was one of the parents of Clean Sky. In the mid 2000s I chaired an industry group – IMG4 – dedicated to European aeronautical research, setting coordinated industry research road-maps. The EC came to see us with the idea of creating a new setting, a Joint Technology Initiative, which should be industry-led, and financially structured in the form of a Public Private Partnership. This was in 2005 – well before the start of CS1, so there was this very exciting, pioneering period, collectively inventing something new – we had to be quite creative. There were intense negotiations over four years between industry and the Commission – we learned to understand each other's constraints and cultures.

In the end, twelve different companies from Safran participated in Clean Sky 1. Internal efforts were necessary to coordinate things and create the processes so that there would be just one representative from Safran at the governing board, and it was a major part of my job. Apropos of that, Clean Sky has been a very good exercise for coordinating Safran's R&T across its different divisions, hence it contributed to increasing the integration of the Safran R&T.

> "The most exciting thing about Clean Sky is working together."

Based on your experience, what should be encouraged about the Clean Sky programme and what is the most exciting thing about Clean Sky?

Firstly, Clean Sky is absolutely key to the implementation of ACARE's Strategic Research and Innovation Agenda (SRIA), responding to the high-level long-term vision for European aviation, Flightpath 2050. Currently the SRIA is being revised for publication in June 2017 and a presentation at le Bourget. I'm co-chairing the Strategy and Integration Board that's leading this update, so we're very busy with that at the moment. ACARE provides this collective vision, and Clean Sky is a major vector to implement it.

A constant challenge is explaining to the political decision-makers that our sector has long cycles – you cannot expect quick results. I understand that for politicians product applications are needed to justify expenditure. Furthermore, innovations in engines or equipment – which can bring major improvements – are not always noticed by the public. Clean Sky 1 came under scrutiny in the early days because we had committed to an ambitious programme. But we delivered, and some of us even spent much more of our own money to do so, which shows our commitment. And that gives me confidence in Clean Sky 2.

Also to be encouraged is more disruptive aircraft concepts. At Safran we've created a new research and technology centre where, amongst a variety of activities, we work on innovative concepts, particularly work on novel propulsion, linked to electric and hybrid aircraft of the future. We're highly motivated to support and propose disruptive concepts with aircraft manufacturers.

The most exciting thing about Clean Sky is working together – this is for me the biggest added value. Once Clean Sky started there was the monumental process of integrating numerous partners, culminating in the gathering of 600 different entities. It's been a powerful catalyst in bringing together Europe's aeronautical research stakeholders, working collaboratively in pursuit of common goals.

CLEAN SKY CREATES HUGE MOMENTUM TO WORK TOGETHER

Gerben Klein Lebbink
Chair of the Clean Sky 2 States Representatives Group. Interview by Paul Sillers.

What is your background and what made you enter the aeronautics sector?

My interest in aeronautics goes back to my youth where I asked questions – why does an aeroplane stay in the air – why doesn't it fall down? I wanted to know how that works, and that persuaded me to pursue an engineering degree. I studied aeronautics at the University of Delft, and after graduation worked across a range of sectors, in areas of computational fluid dynamics, and then I went into technology management – the area I'm still in.

I'm currently working for the Ministry of Economic Affairs in the Netherlands, formulating policy that can stimulate companies and organizations to innovate, and looking at instruments government can use to be effective. This explains my involvement in Clean Sky as well as other programmes across high-tech, systems and materials.

What led you to Clean Sky Joint Undertaking and what first drew your attention to the programme?

Actually, I was involved even before the Joint Undertaking was there. In the mid 2000s the Commission proposed to have a new kind of instrument to stimulate innovation in Europe and in the Netherlands. We had discussions about forming a joint undertaking, a bit like an executive agency. At that time I was working at the Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart, where I led a group looking at linkages between what we were doing at national level and what Europe was doing in space and aeronautics.

In the beginning the Commission thought to focus around very low TRLs. I was involved with ACARE and there were maybe eight different ideas for this aeronautical initiative, ranging from some very far-fetched ideas such as a solar-powered aircraft towards what has become Clean Sky. In the end that's what received most support from industry, from research establishments and also from governments, and that ended up as the Joint

Undertaking. In the early days it was "learning by doing" – there were many "unknown unknowns" when we started the whole thing.

Based on your experience, what should be encouraged about the Clean Sky programme and what is the most exciting thing about Clean Sky?

In terms of "lessons learned" I'd say you could increase the value of the whole thing by making it a bit broader. Clean Sky is focused on the industrial parts and the application and exploitation of research. Of course that's a very important area, but there is a need for new ideas. I'm currently chairing the States Representatives Group within Clean Sky and that's something we keep saying – we also have to look into new ideas. Perhaps we need to have Calls to stimulate projects that are a little bit more far-fetched.

> "In the early days it was 'learning by doing'. Now, it is time for new ideas."

The most exciting thing about Clean Sky is the huge momentum to work together in Europe – small companies and big companies, and Clean Sky has some very nice specifities, so even small SMEs can join. It's of great value to involve SMEs, as I believe innovative ideas are likely to come from these smaller companies. Bigger companies, because of the many levels you have to go through, struggle to get the budget together for far-fetched ideas.

One more thing. Recently somebody from our airline, KLM, came and said "Clean Sky is a big project but what do we see as an airline coming out of it? We'd love to see all the results implemented in our aircraft". That's something we need to think about – how we get it on an airline and see it flying around. Also, I think that many of the new technologies, especially around laminar wing flow could be of interest to longer-haul aircraft – not just for airlines – but also in the executive jet market. Regional aviation is important too. There could potentially be a revival in Europe of regional aircraft manufacture if we joined forces in Europe. But it means investment and requires some entity with the ambition to explore that opportunity.

PROMOTING SYNERGIES AT REGIONAL, NATIONAL AND EUROPEAN LEVELS

José Carlos Caldeira
Presidente, ANI – Agência Nacional de Inovação. Interview by Paul Sillers

What is your background and what made you enter the aeronautics sector?

Currently I'm president of ANI, the Portuguese National Innovation Agency, which is a public agency for promoting knowledge transfer through greater collaboration between academia and industry, and also for promoting technological entrepreneurship. I've been with the agency for three years, and before that I worked in research and with an interface organisation working between academia, industry and research companies. My main focus is in advanced manufacturing systems, although I have been involved in several areas, so my link to aeronautics is more on the process side. I have also been responsible for a production technology cluster in Portugal, very much linked and in-line with European initiatives in manufacturing platforms for future technologies.

We work horizontally across all sectors and one of the emerging sectors that has been quite active in Portugal is aeronautics. In terms of added value and in terms of advanced technologies the National Innovation agency is quite interested in these initiatives, working in aeronautics.

What led you to Clean Sky Joint Undertaking and what first drew your attention to the programme?

The National Innovation Agency is responsible for promoting the participation of national organisations in Horizon 2020, particularly companies, including the Joint Technology Initiatives like Clean Sky – through the national contact points for these initiatives.

We've had contact with Clean Sky for many years since the beginning and have been promoting the participation of the national organisations in this initiative. Participation has been growing and we're more active now, since the beginning of Horizon 2020 – which is also more or less the beginning of my role here in the agency.

For us there's an aspect which is very important: the synergies between European

structural funds and European programmes and the national programmes and national funds. Clean Sky is one of the leading initiatives in this field because for a while they've been promoting arrangements and agreements with national and regional authorities to promote synergies and complementarities between funding at European level and initiatives and funding at national and regional level. We signed a MOU in October 2016 between the agency, the National Science Foundation and Clean Sky to promote collaboration and synergies between what we are doing in aeronautics at European level and at national level. As you can imagine, for an emerging sector, which is the case of aeronautics in Portugal, it's very important.

> "Synergies between European funds for regions and European programmes are key. Clean Sky is one of the leading actors in this field."

Based on your experience, what should be encouraged about the Clean Sky programme and what is the most exciting thing about Clean Sky?

We are working on two levels of synergy: One is how we capacitate Portuguese organisations to have better and stronger participation in Clean Sky – how we reinforce the capabilities, the competences, the critical mass, at national level – how we support the development of the national R&T agendas in those fields. How we organise stakeholders, mobilise them, how we support them in the preparation of proposals and the ideas so that they can have better and relevant participation in Clean Sky.

The other one is the further exploitation of results of the project because at Clean Sky we develop technologies up to a certain level, but then of course we can use complementary funding instruments to take these technologies and bring them to a higher TRL at national and regional level. There's also what we call "cross fertilisation" – some technologies developed for aeronautics have potential to benefit other sectors.

The most exciting thing in Clean Sky is the capability of working together with different countries and the different areas. This capability of mobilising and involving many other stakeholders at national and regional level via these collaborations and via these agreements is a very important aspect of this platform. And I believe that this is the way of clearly taking benefits of the European dimensions that we have as a set of countries, as a community, and also being able to benefit a large number of stakeholders from sectors and regions, so they really have a European dimension.

THE AEROSPACE SECTOR GOES BEYOND NATIONAL BOUNDARIES

Iain Gray
Director of Aerospace, Cranfield University. Interview by Paul Sillers.

What is your background and what made you enter the aeronautics sector?

I remember watching Concorde's first flight on television when I was about 12 years old and thinking – that's a sector I want to get into. So, after graduating from Aberdeen University I joined British Aerospace as a structures engineer at a time when Airbus was just starting, and was fortunate to work on Concorde when it was still on the assembly. There was a strong Anglo-French relationship, so I was introduced to the European ways of working. I suspect that's what led me into BAe's early involvement with the Airbus Consortium with development of the A310 and A320, working my way up to becoming MD of Airbus UK at the time of the A380 wing development.

> "Cranfield has helped shape some of the Clean Sky programmes, and our academics sit on the Advisory Board and the various boards that help develop what the programme looks like."

I left in 2007, becoming Chief Executive of what's now called Innovate UK, responsible for creating economic benefit out of the great science and technology base we have in the UK. What struck me was a number of common themes across different sectors. For example, at the medical research centre in Glasgow, they were analysing blood flows to the brain to predict strokes using the same coding in their analysis tools as those used for the A380 wing development.

As a funding body we were involved with how we position UK companies so that some national research programmes aligned with bigger European programmes. So I had an industry perspective of working with academia, I had a funding body and a public sector perspective on academia, and when I left Innovate UK I was keen to exploit how I could work that triangle – industry, public sector and academia – for the broader benefit of society. But I also wanted to get back to my aerospace roots, which led me, 2 years ago, into my current job as Professor and Director of Aerospace at Cranfield University.

What led you to Clean Sky Joint Undertaking and what first drew your attention to the programme?

My background has involved me in some of the bigger picture research programmes. Increasingly, the size of the challenges and the magnitude of the investment required needs big picture investment. I first got involved in large European collaborative programmes at the outset of Clean Sky 1. Cranfield's engagement is at a number of levels: Expertise available at Cranfield has helped shape some of the Clean Sky programmes, and our academics sit on the Advisory Board and the various boards that help develop what the programme looks like. I've been involved through Cranfield in the ACARE working group exercises, reshaping the agenda, looking at the key technology challenges.

Cranfield is involved in a number of collaborative projects in the Clean Sky programme – with big players such as Airbus, Rolls-Royce, Safran, Thales as well as smaller companies working on specific technologies. We work in partnership with organisations and other universities across Europe in the Clean Sky programme itself, and our major strengths are in propulsion, thermal power programmes, and next generation aircraft configuration concepts. Increasingly we're involved in emerging technologies – hybrid electric, autonomy, and new manufacturing methods.

Based on your experience, what should be encouraged about the Clean Sky programme and what is the most exciting thing about Clean Sky?

Collaboration. In a rapidly changing world – in terms of technology, global challenges, environment and integrated transport systems – no one company or organisation can be expected to do everything. I think the essence of Clean Sky is bringing players together across industry, academia and research organisations to collaborate in a way that can achieve big picture objectives.

We've got to work together to achieve things – because the aerospace sector goes beyond national boundaries. Large corporates, from a research point of view, are based around the globe. The University and the academic network has to adapt to work with those, so, regardless of national boundaries and politics around other things, I think the aerospace agenda transcends all those conversations. We've got to collaborate across the world, to overcome the barriers that sit in the way, and find effective ways of working together.

BEST PROJECTS FROM PARTNERS AWARD 2017

The annual Clean Sky Award for Best Project from Partners took place at the Clean Sky 1 Closing Event on 22 March. From 22 nominated projects, the Z-Damper project was awarded first prize, followed by the X-WALD and GET READY projects. Find out more below!

Z-Damper: A breakthrough technology for attenuation of vibrations

by Professor José Luis Pérez Díaz, *co-founder of MAG SOAR SL*

Inventing is one of Europe's greatest traditions, but it is never an easy task. In the case of Z-Damper it required a rare combination of creativity, talent, technical knowledge, sustained funding, motivation, determination, and a hard-working and multidisciplinary team working together with a love for a well-done job.

MAG SOAR was incorporated in 2013 as a technology-based spin-off from the FP7 Space project MAGDRIVE. Its core business is based on magnetic contactless mechanisms for use in extreme conditions like those in space. MAG SOAR mechanisms have a set of key properties: they do not produce debris, do not need lubrication, do not wear out, are intrinsically immune to overloads and present linear stiffness with zero backlash.

In 2014, MAG SOAR engineers – using this last property – envisaged a completely new device that will completely change the technology for attenuation of vibrations. Using linear magneto-mechanisms they found a way to match mechanical impedances, therefore optimising the performance of all kind of devices for vibration control.

Vibration reduction in the pylon area is a key issue for the feasibility of the new eco-efficient engines and aircrafts. It is well-known that comfort is clearly linked to a low level of vibrations. What is maybe not so well-known is that it is also strongly linked to safety: vibrations must be kept under a threshold to allow pilots to command the aircraft even in the event of a blade loss and the subsequent unbalance of the rotor of the engine. The high temperature in the environment close to the engine is a challenge that no other device can withstand. Z-Damper has been tested between -50ºC and 250ºC, making it absolutely unique for damping in harsh environments.

In this project the Z-Damper technology has been developed up to experimental demonstration of two prototypes in a laboratory starting almost from scratch, including designing and making a test-bench as well as the development of software for helping engineers to customise the best Z-Damper for their vibration attenuation needs. EU, USA and PCT patents have been applied for, with a very positive State of Art Report.

The usefulness of this technology clearly goes beyond the limits of the aeronautical industry. It seems that a mechanical impedance matching device can help make buildings safer against earthquakes, will reduce the space and weight of devices needed for the stabilisation of skyscrapers, wind power generators and other large structures, and will efficiently suppress vibrations in vehicles.

For a small company like MAG SOAR S.L., participating in the Clean Sky programme has been a great opportunity to create value but has also demanded a significant financial effort. Now, the challenge is to make it quickly competitive in the market.

Z-Damper (Impedance-Coupled Full System for Attenuation of Vibrations) was a 22-month project as part of the Smart Fixed Wing Aircraft ITD. It was led by the technology-based company MAG SOAR S.L. in cooperation with Universidad de Alcalá, with 12 researchers involved and a total budget of €602,000. At the end of the Z-Damper project in April 2016, two prototypes of this absolutely new technology for mechanical impedance matching and attenuation of vibrations were successfully tested in relevant conditions.

Avionic X-band Weather signal modelling and processing vALidation through real Data acquisition and analysis – X-WALD

by Fabrizio Berizzi, Fabrizio Cuccoli, *Radar and Surveillance Systems Lab. of CNIT, Italy*

All civil airplanes and military transport aircrafts are currently equipped with avionic weather radars (AWR) with single polarisation. Single polarisation radar only allows for the detection of the intensity of the meteorological phenomenon related to harsh and dangerous conditions, like hailstorms and strong turbulence.

Polarimetric radars can provide more refined information about the type of precipitation once the model of specific hydrometeor (rain, snow or hail) is known. Polarimetry is commonly exploited in ground-based meteorological radar for weather forecasting.

In the framework of the Clean Sky programme, specifically the Systems for Green Operations (SGO) Integrated Technological Demonstrator (ITD), the use of a polarimetric avionic radar was proposed in the Management of Trajectory and Mission (MTM) study to get more accurate information about unforecasted weather phenomena.

One of the SGO goals is to optimise the skipping trajectories in order to minimise the noise pollution and emissions during each flight phase of the airplane. To this purpose, the CLEOPATRA and KLEAN projects were supported for the development of an avionic polarimetric radar signal simulator (CleoSim), implementing and testing polarimetric signal processing and trajectory optimisation algorithms on an EFB (Electronic Flight Bag). Then the X-WALD project was sponsored to validate the results achieved in KLEAN and CLEOPATRA.

The overall objectives of the X-WALD project were the planning and execution of ad-hoc measurements finalised to test, validate and optimise the CleoSim radar signal simulator, the radar signal processing and weather classification algorithms implemented on the EFB in the KLEAN project.

To achieve these objectives, an X-BAND polarimetric radar was selected and updated for avionic purposes. The main X-WALD achievements are:

- measurement campaigns with two different aircrafts (The Netherlands: December 2015 – Italy: March 2016)
- radar data processing optimisation and validation of the avionic polarimetric radar signal simulator (CleoSim)
- optimisation and validation of the EFB weather radar signal processing and trajectory optimisation algorithms
- implementation of the Graphical User Interface on the EFB for the advanced display of weather classifications and decision-making advices.

The X-WALD project allowed, for the first time in Europe, polarimetric measurements in bad weather conditions to be gathered with a prototype of avionic polarimetric weather radar.

Partners: Consorzio nazionale Interuniversitario delle Telecomunicazioni (IT), Ingegneria dei Sistemi (IT), Metasensing (NL), Politecnico di Milano (IT)

High speed turbine casing produced by powder HIP technology – GETREADY

by Sara Biamino, *Associate Professor in Material Science and Technology, Politecnico di Torino and* Daniele Ugues, *Associate Professor in Metallurgy, Politecnico di Torino*

The 'High speed turbine casing produced by powder HIP technology – GETREADY" is a Clean Sky 1 project related to the Sustainable and Green Engines (SAGE) ITD. The project started in September 2014 and ended in February 2016. The Italian INSTM (Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali) coordinated the project through the research unit of Politecnico di Torino directed by Prof. Sara Biamino and Prof. Daniele Ugues of the Department of Applied Science and Technologies. The other participants were the French company Aubert & Duval and the INSTM research unit of Politecnico di Milano. The whole project involved 20 people. Avio Aero was the topic manager and end user of the developed demonstrator. The total cost of the project was €829,300 with €506,600 of funding by the EU.

The GETREADY project was aimed at the application of the powder Near Net Shape Hot Isostatic Pressing (NNSHIP) manufacturing route to the fabrication of a casing for a high-speed turbine. Constitutive material was the Ni-superalloy Astroloy which is hardly formable via traditional manufacturing routes.

Within this project, the Consortium has successfully:

1) applied NNSHIP to the fabrication of two Astroloy turbine casings as full-scale demonstrators (diameter about 1.2 m and height about 0.5 m);
2) greatly reduced the wasting of material: the process was optimised to achieve a final overstock of less than 1.5 mm. Furthermore, passing from forging to NNSHIP, the usage of raw material passed from 13 to 75%, while total energy consumption was reduced from 156 to 28 MJ;
3) optimised the heat treatment for the casings with a saving of 24 hours;
4) performed a complete and certified mechanical characterisation;
5) developed a physical modelling of the powders with numerical simulation tools, in order to simulate the densification process allowing it to be adapted to any possible component design.

The demonstrator developed during GETREADY was awarded in October 2016 by the European Association of Powder Metallurgy (EPMA) with the 1st prize for best 'Hot Isostatic Pressing Part of the Year", in Hamburg (Germany) http://bit.ly/2r7Qel0

An increase, in 3 years, to 1000 casings per year produced via NNSHIP technology is forecast.

BEST CLEAN SKY PHD AWARD 2017

The annual awards for the Best Clean Sky PhD were presented at the Clean Sky 1 Closing Event on 22 March. This prize acknowledges the importance of young scientists for the greener aviation of the future. First prize was awarded to Dr. Fei Gao (University of Nottingham) for his thesis 'Decentralised Control and Stability Analysis of a Multi-Generator Based Electrical Power System for More Electric Aircraft'. Second and third places went respectively to Dr. Vincenzo Citro (University of Salerno) and Dr. Angeliki Chanteli (University of Patras). Learn more about the winners and their work below!

First prize

by Dr Fei Gao

Postdoctoral Research Associate, Department of Engineering Science, University of Oxford

I am very delighted to have won this Best PhD Award 2017. I would like to express my heartfelt appreciation to my parents for their support and my deepest gratitude to my PhD supervisors from University of Nottingham for their guidance. In addition, many thanks to Clean Sky for the exciting project which greatly motivates me. Within the framework of the Systems for Green Operation (SGO) ITD (WP2.4), my PhD was to deal with power management, control and stability analysis for a multiple generator based more-electric aircraft (MEA).

MEA concept is one of the major trends in modern aerospace engineering, aiming for a reduction of the overall aircraft weight, operation cost and environmental impact. As a consequence, the onboard installed electrical power increases significantly and this results in challenges in the design of the aircraft electrical power systems (EPS). The EPS architecture with high voltage DC distribution is considered one of the most promising candidates due to potential advantages such as higher efficiency compared to AC, absence of reactive-power related issues, and reduced costs.

A 'single bus' architecture with multiple parallel sources is investigated in my PhD project. It assumes that three sources controlled by power electronic converters provide power to the common DC bus. In such a context, the parallel sources idea will lead to: (1) possibility of power sharing among different sources with a minimisation of the total weight of generation systems, (2) ease of energy management and power flow control, (3) convenient integration with power sources of different nature (fuel cells, batteries, etc.), and (4) improved availability of electrical energy onboard.

The proposed 'single bus' EPS was successfully achieved in this PhD project, analytically and experimentally, through the following objectives:

1. To develop methods of power management among the multiple sources.
2. To propose voltage control approaches to improve the power quality.
3. To investigate stability conditions of different droop control approaches and provide a guideline to design a stable EPS.

The novelty and impact of my PhD project can be summarised as follows:

- Proposed enhanced bus voltage control approach can be easily implemented to improve the power quality and reduce the system losses.
- A comprehensive modal analysis provides the framework for tuning the key EPS parameters including component parameters, operating parameters, and control parameters of MEA EPS. It provides a guideline to choose these parameters to ensure stable EPS operation in a wide range of conditions.
- The PhD project has wide dissemination: it has resulted in more than 23 journal/conference publications and a few book chapters.

To summarise, my PhD work can be regarded as a contribution towards the next generation of MEA EPS, improving their efficiency, equipment weight and volume, power quality, stability margins, and coordination of power sources, possibly of different physical natures. The developed principles of multi-generator based EPS are now being exploited within Clean Sky 2 Core Partner projects. Overall, the findings of my PhD project support the move towards greener aviation and are well-aligned with Clean Sky objectives and ACARE FlightPath2050 Goals.

Fei with his supervisor Dr. Serhiy Bozhko (University of Nottingham)

Unsteady and three-dimensional fluid dynamic instabilities

by Dr Vincenzo Citro

In the past decades aeronautical, economical and environmental needs have reinforced the interest in understanding laminar-turbulent transition and in the design of efficient methods for control shear flows. A crucial point that has driven the development in this field is the availability of larger and larger computational resources. There is a need to design efficient algorithms and methods to accurately simulate flows of aeronautical relevance. Therefore in this thesis, the stability and transition of several flow configurations of aeronautical relevance, such as the flow over a helicopter blade or the flow past a roughness element, were investigated.

Suitable CFD (Computational Fluid Dynamics) tools play an important role in the analysis of the environmental impact of aircraft with regards to emissions; in particular, they contribute to achieving the objectives for technology readiness to reduce fuel consumption and hence emissions, as well as contributing to the competitiveness of the European manufacturing industry. Through this thesis, tools were developed to improve the efficiency of existing CFD codes: to accelerate or stabilise a numerical simulation (BoostConv), and to define an optimal grid refinement criterion (ESR).

Therefore, this thesis has shown the effective possibility to develop theoretical and numerical tools to study the transitions on boundary layers developing on the blade of helicopters or on other aeronautical configurations. The detailed studies performed during the PhD have highlighted the existence of several issues related to the nature of the equations and their discretisation which need to be properly accounted for in order to correctly model the transition process. These studies have provided a deeper understanding of physics involved in the boundary layers and transition processes which may be useful in the design of a laminar blade.

A numerical multi-scale methodology for the parametric prediction of mechanical properties of CNT-reinforced polymers and composites

by Dr Angeliki Chanteli

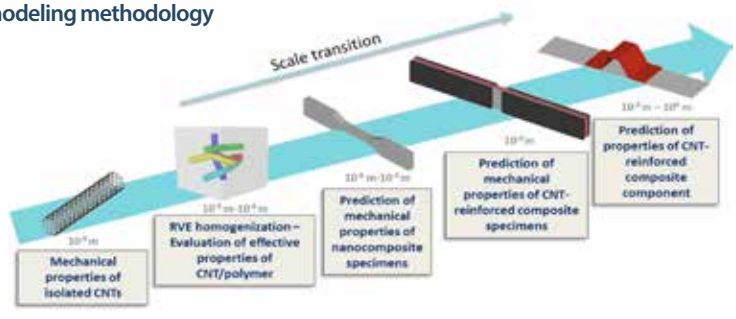
Throughout the past few decades the demanded manufacturing of aeronautic structural components introduced composite materials with integrated multifunctional characteristics. These enhanced mechanical properties have lately been studied for more damage-tolerant composite aircraft structures. Especially, reinforcement of polymeric matrix composites with carbon nanotubes (CNTs) may significantly improve their mechanical properties. However, early experimental results have revealed the dependence of reinforcement effectiveness on several parameters related to quality, manufacturing process, the geometry of CNTs, the CNT/polymer interphase and the dispersion of CNTs. The effects of these parameters are mainly investigated experimentally by manufacturing trials, mechanical tests and microscope observations (scanning electron microscopy (SEM), atomic force microscopy (AFM), etc.). Since this is a very time-consuming and expensive process, there is a demand for developing efficient virtual designs for the optimisation of multifunctional composites.

The main objective of the thesis is to develop a continuum-based multi-scale methodology for predicting the mechanical properties of polymers and polymeric matrix composites reinforced with carbon nanotubes (CNTs).

To achieve the purpose of the thesis, finite element models were developed from the nanoscale to macroscale, as shown in Fig. 1. Additionally mechanical, microscopy and nanoindentation tests were conducted to obtain input data and validate the models, where the objectives are the development of a parametric finite element model of CNT agglomerate, the development of a methodology for the characterisation of CNT agglomerates from SEM data, to obtain input data for the models while conducting SEM, AFM and nanoindentation tests, and also to perform tension tests in nanocomposites for validating the models.

The novelties of the thesis can be briefly mentioned as: the simultaneous evaluation of different parameters that can affect the effective mechanical properties of CNT-reinforced polymers and composites, the development of a multi-scale model for evaluating the integrity of sub-component parts made from CNT-reinforced composite materials, the development of detailed parametric finite element models of CNT agglomerates, the development of a methodology that describes the geometrical characteristics of CNT agglomerates by exploiting SEM images and the developed numerical methodology which is capable of bridging scales from nano- to macro-scale. Therefore, it can be used for the virtual design and optimisation of aeronautic structural parts made from multifunctional composite materials in order to save development time and cost. Minor modifications on the proposed methodology can introduce the consideration of electrical and thermal properties as well.

Schematic representation of the multi-scale modeling methodology



GET INVOLVED: HOW TO APPLY TO A CLEAN SKY 2 CALL

Clean Sky owes its success to the diverse expertise, skills, knowledge and resourcefulness of its participants, including specialists from across the aviation industry, research centres, universities, small and medium-sized enterprises, and others. Since its launch in 2014, Clean Sky 2 has brought over 150 Members on board through three Calls for Core Partners, with the fourth and final Call being processed, and over 300 Partners through five Calls for Proposals (for Partners). With more Calls for Proposals to come over the next three years, learn how you can become a part of Clean Sky 2 with our FAQs below!

What is the difference between a Core Partner and Partner?

Clean Sky 2's Core Partners are private or public organisations that have applied and been selected through an open and transparent competition to become permanent Members of the Clean Sky 2 Joint Undertaking. They commit to performing and completing certain work packages in one or more technology platforms, usually for the full duration of the programme. They support the programme financially with in-kind contributions, and can receive up to 30% of the programme funding for their projects.

Partners are private or public organisations that take part in certain specific tasks for a limited period of time. They join the programme through successful applications to Calls for Proposals which are open to everyone, including industry, SMEs, research centres and universities.

Who is eligible to apply to Calls for Proposals?

Clean Sky 2's Calls for Proposals are open to:

- Single entities (industry, SMEs, research organisations, academia etc.)
- Consortia of legal entities
- Clusters (groupings of entities applying as a single entity to perform work jointly

There is no requirement to build a consortium with a minimum number of participants or representing a minimum number of Member States or H2020 Associated Countries. This is based on a derogation that the Clean Sky 2 Joint Undertaking has from the H2020 rules for participation, due to the fact that a selected entity, once joining the programme, is basically joining an already-established European-level collaborative effort involving a large number of participants. This derogation was already applicable to Clean Sky 1 projects under FP7, where about 50% of the Calls for Proposals were answered by single applicants and about 30% were answered by 2 joint applicants, often an SME and a university.

What are the applicable funding rates for the projects?

In Clean Sky 2 there are three types of actions: 'Research & Innovation Actions' (RIA), generally more 'upstream' in their research nature, which are related to technology enablers and/or a somewhat lower Technology Readiness Level (TRL); 'Innovation Actions' (IA) which generally involve the progression towards higher levels of technology integration, demonstration, and often a higher TRL; and Coordination and Support Actions (CSA), which generally provide service e.g. for the preparation of studies. In accordance with H2020, RIAs and CSAs are funded at 100% of the Total Eligible Cost (direct costs), and IAs at 70% of the Total Eligible Cost (direct costs). However, if an organisation is recognised and validated as a Non-Profit Entity (NPE), it can apply for 100% of the Total Eligible Cost for both types of actions. The indirect costs are always funded at a 25% flat rate level, again in full compliance with H2020 rules.

In our Calls for Proposals (for Partners), each topic is separately categorised based on the nature of the actions required.

If my company wins a CfP topic, is it entitled to pre-financing?

Pre-financing is foreseen for all projects/actions in Clean Sky 2 in accordance with the Clean Sky 2 model grant agreements which are mainly based on the H2020 model. Nevertheless, there is no standard percentage of pre-financing payment. In principle, up to 100% of the average JU funding per reporting period can be paid up-front as pre-finance for actions with at least two reporting periods; however, this is only a general guideline and pre-finance levels may vary based on the individual calls, the type of project, and the budgetary availability of the Joint Undertaking.

What is the 'Participant Guarantee Fund'?

'The Fund' was established in order to mitigate the risks associated with the amounts due and not reimbursed by any defaulting participants. The participants' contribution to the Fund (5%) will be deducted from the initial pre-financing. At the end of the action the amount contributed to the Fund will be released and returned to the participants, via the coordinator.

If I am a Core Partner, can I still apply for CfPs?

- Core Partners and their affiliates (once selected) may apply in subsequent waves of Calls for Core Partners in all IADP/ITD/TAs. (Note: certain conditions for the avoidance of a Conflict of Interest (CoI) will apply, for which the CS2JU Work Plan and its annexes and the rules governing calls provide guidance, and for which applicants will need to sign a declaration stating there is no CoI.)
- Core Partners (once selected) may subsequently apply to Calls for Proposals only in another IADP/ITD/TA where they are not (yet) selected as a Member.
- The Partners selected via a Call for Proposals may subsequently apply to Calls for Core Partners and Calls for Proposals in all IADP/ITD/TAs.

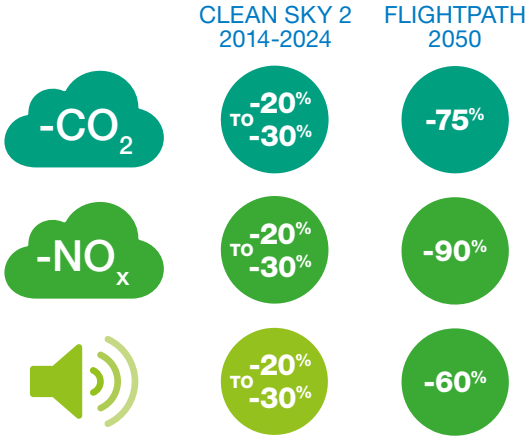
Find more information on www.cleansky.eu

THE EUROPEAN AVIATION PARTNERSHIP

Clean Sky 2, part of the EU's Horizon 2020 Framework Programme, is the largest research programme in aviation ever launched in Europe. Building on and extending the scope and technological gains from the first Clean Sky programme, Clean Sky 2 works towards more ambitious goals and extends its reach across longer-term and lower-TRL actions, for nearly all sectors of aviation, in order to:

- Accelerate the adoption of new technology into the global fleet, meeting society's need for air transport with a minimal environmental impact and addressing both the EU's contribution towards the Energy Union and the threat of global climate change;
- Complete the journey towards full accomplishment of the ACARE SRIA Goals for 2020;
- Kick-start the progress towards the ACARE SRIA goals for 2035-2050;
- Enable a technological leap in the face of existing as well as emerging competitors.

CLEAN SKY 2 **OBJECTIVES**



TECHNOLOGY **EVALUATOR**

The Technology Evaluator is assessing the environmental impact of the innovative technologies developed in Clean Sky. It determines Clean Sky's contribution to the reduction of CO_2, NO_x, and noise.

ASSESSMENT 1
AT MISSION LEVEL

ASSESSMENT 2
AT AIRPORT LEVEL

ASSESSMENT 3
AT FLEET LEVEL

Three Innovative Aircraft Demonstrator Platforms (IADPs)

Integrating technologies and major systems innovations; demonstrating and validating their potential at the full vehicle level, towards future aircraft configuration.

Large Passenger Aircraft

Regional Aircraft

Fast Rotorcraft

Three Integrated Technology Demonstrators (ITDs)

Developing and integrating new technologies, with demonstrator projects validating these at major system level.

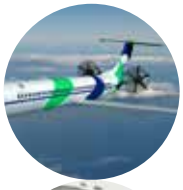
Airframe

Engines

Systems

Two Transverse Activities

Focusing on specific applications and technology challenges across the IADPs and ITDs enabling synergies to be exploited between different platforms through shared projects and results.



Small Air Transport

Eco Design

CELEBRATING THE FIRST 10 YEARS OF CLEAN SKY!

The Clean Sky event 'Europe, Innovation and Aviation – Are we keeping up?' took place on 21-22 March in Brussels to mark the closing of the Clean Sky 1 programme. The event featured many keynote speeches by high-level representatives from the industry, European Parliament and the European Commission, including Carlos Moedas, European Commissioner for Research and Innovation. The technical platforms of Clean Sky 1 were the focus of the second day of the event, with breakout sessions dedicated to reporting the results and achievements. Several award ceremonies took place to honour those who have supported the Clean Sky programme, including Chairs of the Governing Board and members of the Scientific Committee and States Representative Group. Awards for the Best Project from Partners and Best PhD were also presented.

Thank you to all those who attended the event! News and pictures are available on our website now.

"To remain competitive globally, we must invest in research to be at the cutting edge of new technologies – Clean Sky is about just that."
Christian Ehler, MEP

"Our industry can still grow. Clean Sky plays an important role in developing new technologies."
Philippe Petitcolin, Chief Executive Officer, Safran

"We must maintain this successful tradition of partnership, collaboration and unity if we are to overcome the challenges facing the future of aviation."
Carlos Moedas, European Commissioner for Research and Innovation

"We need to make sure we are leading with the best technologies at the global level. Clean Sky: we need it."
Paul Eremenko, Chief Technology Officer, Airbus

Interim Executive Director: Tiit Jürimäe
Editor: Maria-Fernanda Fau, Advocacy and Communications Manager

The Clean Sky 2 Joint Undertaking receives funding under the Horizon 2020 Programme for research and Innovation.

Find us on: